LOW RESISTANCE ANTIPARALLEL TAB MAGNETORESISTIVE SENSOR

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a magnetic spin valve sensor typically used in a magnetic disk drive; and, more specifically, to an antiparallel tab magnetic spin valve sensor having a very low resistance conducting path.

[0003] 2. Description of the Background Art

[0004] Disk drives using magnetic recording of digital information store most of the data in contemporary computer systems. A disk drive has at least one rotating disk with discrete concentric tracks of data. Each disk drive also has at least one recording head typically having a separate write element and read element for writing and reading the data on the tracks. The recording head is constructed on a slider and the slider is attached to a suspension. The combination of the recording head, slider, and suspension is called a head gimbal assembly. In addition, there is an actuator which positions the recording head over a specific track of interest. The actuator first rotates to seek the track of interest. After positioning the recording head over the track, the actuator maintains the recording head in close registration to the track. The disk in a disk drive has a substrate and a magnetic layer formed over the substrate for magnetic recording. The slider carrying the recording head has a disk facing surface upon which an air bearing is constructed. The air bearing allows the slider to float on a cushion of air and to be positioned close to the disk surface. Alternatively, the slider surface facing the disk can be adapted for partial or continuous contact with the disk. The read element in most contemporary disk drives include a magnetic spin valve sensor. A magnetic spin valve sensor is a sandwich of layers including a ferromagnetic pinned layer, a nonmagnetic electrically conducting layer, and a ferromagnetic free layer. The resistance of the spin valve sensor changes with respect to the direction and magnitude of an applied magnetic field such as the field from a written magnetic transition on a disk. To detect the change in resistance, sense current is passed through the sensor.

[0005] The free layer in a magnetic spin valve sensor is usually operated in the presence of a constant weak magnetic field to insure magnetic stability and prevent spurious signals. The application of a weak magnetic field to the sensor is sometimes referred to as magnetically biasing or magnetically stabilizing the sensor. One structure which may effectively be used for magnetic biasing is a pair of magnetic stabilization tabs which are antiparallel coupled to portions of the free layer. This biasing structure is effective. However, there are two practical problems. One, during annealing an oxide layer typically forms on the cap layer. This oxide layer must be thoroughly removed by ion milling before formation of the lead structures. If the oxide layer is not completely removed the resistance of the sensor increases. Since this additional resistance, sometimes called parasitic resistance, is not related to the sensor response to an external magnetic field, the effective sensitivity of the sensor is degraded. Two, the above mentioned ion milling operation easily causes damage to the magnetic biasing layer in the magnetic tabs. The most common damage from ion milling is a loss of magnetic moment of the magnetic biasing layer. It is important that the magnetic biasing layer have a slightly higher magnetic moment than the adjacent portion of the free layer. The magnetic biasing layers are very sensitive to damage from ion milling and therefore this sensor architecture is difficult to manufacture.

[0006] What is needed is a magnetoresistive sensor having antiparallel coupled bias tabs which has low resistance and is easy to manufacture.

SUMMARY OF THE INVENTION

[0007] A preferred embodiment of the invention provides a magnetoresistive spin valve sensor which has novel antiparallel coupled bias tabs. Each antiparallel biasing tab includes a ferromagnetic biasing layer which is antiparallel coupled with a portion of the free layer. Each antiparallel biasing tab also includes both a cap layer and a protective cap layer. The presence of the protective cap layer prevents oxidation of the cap layer during annealing. The presence of the protective cap layer also avoids an ion milling operation to remove oxidized material thus preventing possible damage to the bias layer.

[0008] An embodiment of a magnetoresistive sensor thus provided by the invention has a lower resistance and has very low risk for damage to occur to the biasing layers during manufacture. Another embodiment of the invention provides a disk drive having a read element including a magnetoresistive sensor with antiparallel coupled bias tabs with a protective cap layer. Other aspects and advantages of the invention will become apparent from the following detailed description, which, when taken in conjunction with the drawings, illustrate by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] **FIG. 1** illustrates a view of a disk drive having a magnetoresistive sensor according to the present invention;

[0010] **FIG. 2** illustrates a view (not necessarily to scale) of a slider and recording head having a magnetoresistive sensor according to the present invention;

[0011] **FIG. 3***a* illustrates a disk facing view (not necessarily to scale) of a magnetoresistive sensor before annealing according to the prior art;

[0012] **FIG. 3***b* illustrates the magnetoresistive sensor after annealing according to the prior art;

[0013] **FIG. 4***a* illustrates a disk facing view (not necessarily to scale) of a magnetoresistive sensor having a protective cap layer before annealing;

[0014] **FIG. 4***b* illustrates a view of the magnetoresistive sensor having a protective cap layer after annealing and formation of the photoresist liftoff structure;

[0015] **FIG. 4***c* illustrates a view of the magnetoresistive sensor after deposition of lead material;

[0016] **FIG. 4***d* illustrates a view of the magnetoresistive sensor after liftoff of the photoresist;

[0017] **FIG. 4***e* illustrates a view of the magnetoresistive sensor undergoing ion milling;

[0018] **FIG. 4***f* illustrates a view of the magnetoresistive sensor undergoing fluorine reactive ion etching;